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* SPECIAL REPORT *
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Special Report -- Advanced Research Projects Agency

Here is a special report on the program plans and policies of the Advanced Research Projects Agency for the Fiscal Year which begins July 1, 1960. This Agency is rapidly departing from operational "hardware" programs in favor of advanced research in the military sciences and in military astronautics and related equipment.

ARPA currently plans, initiates and directs specific research and development projects assigned by Dr. Herbert York, Director of Defense Research and Engineering. Programs are carried out in government laboratories and arsenals and through contract or grant arrangements with industry, research institutions and educational institutions.

Military Sciences

* Ballistic missile defense, Project Defender: 1960, $106 million; 1961, $110 million.

The goal of this program is to provide the U.S. with advanced ballistic missile defense systems which are technically, operationally, and economically feasible. Project Defender covers approximately 150 contracts awarded over the past 18 months.

ARPA officials believe that the ballistic threat to the U.S. is of such a nature that conventional concepts (Nike-Zeus antimissile system is included in this category) will eventually be inadequate. They declare that the development of so-called "advanced active ballistic missile defense systems" is one of the most vital considerations facing the U.S., and also presents one of the most challenging technical problems with which scientists and engineers must contend.

* Project Defender, Exploratory Investigations: 1960, $11 million; 1961, $11 million.

The objective of this program is, through analysis and experimentation, to investigate new possible defense system concepts, new techniques and basic information. The program is broken down into two broad areas. Defense complex studies include work on the nature and influence of the missile threat variables, evaluation of mixed system cost effectiveness and strategic threat studies and war gaming studies and information exchange.

* Project Defender, Physics: 1960, $10 million; 1961, $10 million.

This program is based on the belief that a better knowledge of atmospheric physics might assist in designing techniques for improved detection, discrimination and kill of ballistic missiles at various points along their trajectory. Other fields of study include rocket exhaust physics, the physics of re-entry phenomena and physics of high altitude chemical releases; the interactions between the atmosphere and solid bodies traveling at high velocities.

Work underway ranges from basic physics studies of atomic cross sections and molecular interactions to probable launchings, and the use of a special ionospheric radar to study electron density. The release of chemicals at high altitudes and study of artificial electron clouds and luminescence will also, it is hoped, provide basic data useful to better understanding the medium in which weapons systems must operate.

During the past year, work on radar blackout has resulted in a decision to increase radar frequencies for terminal units, and work on re-entry phenomena has indicated possible techniques of discrimination between decoys and re-entry warheads.

* Project Defender, Data Processing: 1960, $2 million; 1961, $2 million.

This program relates to the data network required for coordination of the defenses against ballistic missiles, the doctrines of target evaluation and weapon assignment, the place of the human in an automatic missile defense system and the study of general data processing techniques aimed at the discrimination problem. Work is underway to define, in engineering terms, the types of network problems that must be solved and to develop computer techniques of weapons assignment.

Work accomplished under this program is said to include: Development of concepts for processing multistatic radar information; development of small high capacity processing techniques using acoustic distortion to modulate light beams in refractive media and development of extremely high capacity, high-speed storage devices.

* Project Defender Target Discrimination: 1960, $4 million; 1961, $4 million.

This program is designed to meet the threat of possible enemy countermeasures such as decoys and jammers and to reduce the probability of an enemy saturating, confusing or avoiding a defense system. Major objective of the discrimination program is to perform research which will lead to successful attainment of a counter-countermeasure capability. This has already led to the development of a better understanding of capabilities and limitations of various discrimination techniques and has resulted in the discontinuance of some techniques and the placing of increasing emphasis on others.

* (Extra copies of this six-page Special Report are available to subscribers. Single copies, 50 cents; 5 copies, $2. Write Service Department, Washington SCIENCE TRENDS, National Press Building, Washington 4, D.C.)

* Project Defender, Interception, 1960, $2 million; 1961, $2 million.

This program concerns the advanced experimental and theoretical techniques to be used in the design of hypersonic vehicles capable of intercepting ballistic missiles or satellites at long range outside the atmosphere. Includes all design and development problem areas pertaining directly to the interceptor vehicle from the time it is launched from its platform -- whether ground-based, airborne or space-based -- until its payload is successfully delivered to the vicinity of the offensive weapon. Speed, rapid maneuverability and advanced guidance and control are requirements which will be investigated with a wave-super-heater hypersonic tunnel being constructed at Buffalo, N.Y. ARPA is also interested in a low-inertia means of varying the thrust vector for highly maneuverable exo-atmospheric interception.

* Project Defender, Kill Mechanisms: 1960, $6 million; 1961, $9 million.

This program covers the research effort designed to define more closely the kill capabilities of mechanisms now relied on for destruction of ballistic missile nose cones and to discover techniques of greater effectiveness.

ARPA explains that the warhead re-entry body of ballistic missiles is particularly durable and can be destroyed only by extreme measures, which are under study. The special weaknesses of satellites will also be investigated since instrumentation required to carry out their function may be susceptible to kill by means that will be ineffective against warheads. In addition, satellites, unless they are designed for re-entry, are not as durable. However, there are other difficulties, such as the problem of interception of satellites at great heights.

This program will continue to support research designed to define kill potential of existing mechanisms but major emphasis will be on investigating, analyzing and devising new methods of destroying ballistic missiles.

* Project Defender, Missile Range Measurements: 1960, $46 million; 1961 $57 million.

This program is designed to observe and study ballistic missiles in their actual environment during launch, midcourse flight and re-entry. Data are gathered on such physical phenomena as electromagnetic emissions, ultraviolet, visible light, infrared and microwave radiations and from the wave and trails resulting from the missile. Current instrumentation is shipborne, ground-based and carried aboard special KC-135 and C-130 aircraft. In addition, instrumentation is being provided for use on IRBM and ICBM vehicles to obtain background data and rocket plume and nose cone measurements.

Range measurements are supplemented by the analytic and laboratory investigations through the atmospheric physics program.

Increase in this year's program is largely due to two radars, Tradex and Pincushion and other sensors as well as computational equipment to provide for real-time data processing to be installed in the Pacific at Kwajalein. This installation will track and study Nike-Zeus test firings against ballistic missiles and will also permit observation of training missiles launched from Vandenberg and Point Arguello on the West Coast.

* Project Defender, Radar: 1960, $25 million; 1961, $15 million.

This research program is intended to advance the state of the art in the radar components and subsystems necessary to develop long-range high-capacity, high resolution radars significantly beyond the capability of those that exist today. The development of more powerful equipment for range measurements and technique demonstrations is included, as well as applied research in new radar implementation methods and both basic research and exploratory development on components for ballistic missile defense radars, including new high-power tubes, R.F. sources, improved accuracy, low-noise receivers and information extraction.

Developments to date include a high frequency multiple-beam radar known as Pincushion, initiation of development of a superpower microwave tube, continuation of research in high power components, radar receiving techniques, and signal processing techniques. Development is continuing on Ordir, a multistatic radar using triangulation techniques along a baseline of from tens of miles to 200 miles or more which is expected to increase the precision of locating individual objects. Data links of very high quality will be required. Work is also continuing on ESAR, a multi-element electronically scanned radar. This device is planned as a radar in which several emitters reinforce one another and focus on a single point. By shifting the phase of the emissions the point can be shifted electronically, in effect multiplying the power of all the emitters.

* Solid Propellant Chemistry: 1960, $18 million; 1961, $17 million.

The goal of this program is a solid propellant for missiles with at least ten percent higher specific impulse than any now under development. This is expected to permit proportionally greater missile ranges, considerably higher payloads, greater accuracies or significant reductions in the gross weight of the missile. Or, as an alternative, an increase in payload capability could be employed to provide decoys or warhead hardening or combination. It is anticipated that it may take as long as five to six years to produce the higher energy propellants for use in the advanced versions of Minuteman, Polaris and Pershing type missiles.

Two-thirds of the funds for this program are directed to the synthesis of new potentially powerful materials which have never been made before, and testing these in small-scale engines. More than 20 laboratories are engaged in this work, and ARPA says that one of the most important advances to date is the synthesis of promising new compounds of fluorine. It is anticipated that some of the more promising programs can provide test-firing quantities by Calendar 1961.

The remaining one-third of the program funds is in supporting research involving about 30 laboratories. This program is aimed at the efficient development and utilization of the new chemicals as they become available.

* Project Vela: 1960, $8,100,000; 1961, $20 to $60 million (Est.)

This project consists of research and development on technical problems associated with the moratorium on nuclear testing. Details are still classified.

* Materials Research: 1960, $240,000; 1961, $17 million.

This is the newest ARPA program, with a major increase in funding and the expectation that this level will continue or increase in the years ahead. The major objective is the augmentation of basic research in the field of materials through the establishment of so-called interdisciplinary laboratories at selected universities.

ARPA believes that this type of program will foster the "team approach" to materials, bringing to bear the combined knowledge of such fields as solid state physics, inorganic chemistry, high-temperature chemistry, metallurgy, metallurgical engineering and ceramic engineering. In addition to new knowledge, the program is expected to increase substantially the number of suitably trained engineering and scientific personnel at the Ph.D. level.

Over 30 interested colleges and universities were invited to submit proposals for the program. Representatives of the Army, Navy and Air Force have joined ARPA in screening this list for the selection of three universities to be supported with funds to be made available from 1960 appropriations. If Congress approves, an additional three universities will be selected in each of the next two years.

In addition to the interdisciplinary laboratory program ARPA is supporting the procurement of specialized materials research equipment for some 60 universities throughout the nation which already have "going programs" in materials research being supported by the Army, Navy and Air Force. These funds are available through grant authority authorized by Congress last year and amount to about $3 million a year for two years.

Military Astronautics

* Communications Satellites: 1960, $46 million; 1961, $42 million.

ARPA is concentrating its activities on active relay communication systems, leaving the development of passive reflector systems to the National Aeronautics and Space Administration and Project Echo. Within its field ARPA is supporting Project Courier, a delayed active repeater system and Project Advent, a combination of its now "re-designated" Project Steer which called for an instantaneous active repeater for ground to air communications with aircraft in polar regions and Project Decree, a 24-hour synchronous, real-time global system.

* Project Courier: This concept would include within a satellite a number of receivers and transmitters with associated tape recorders. As the satellite passes in orbit over a ground station it is commanded to receive a message, which is then stored on the tape recorder within the satellite. At the next ground station the satellite can be interrogated and transmit the stored message.. Program consists of a series of three launches with a backup -- two during this calendar year. Construction of the first model is believed to have been completed and ground equipment is under construction at Puerto Rico, with a transportable station planned for use in the U.S. Thor-based vehicles will be used for launching satellites of 500 pounds with a capacity equivalent to 20 teletype channels of 100 words per minute.

* Project Advent

As noted, this program is now in a state of flux, having been "re-oriented" and apparently delayed.

Project Steer was to have had the objective of placing a communications package in polar orbit at 5,600 miles altitude, with ground stations in the continental U.S. and aircraft instrumented to receive and transmit through the satellite. Contracts had been let for both the satellite vehicle and the communications payload and ground-aircraft equipment, with the first launching in a five-to-six satellite system scheduled for the second quarter of Calendar Year 1961. The system was reportedly designed to facilitate communications with Strategic Air Command bombers in the polar regions, where normal communications are often disturbed.

Project Decree was to have provided for the placement of a real-time radio communications relay in a satellite in a 19,000 nautical mile or so-called 24 hours orbit. It is believed that a system of three such satellites over the equator would provide complete global coverage between the Arctic and Antarctic circles.

By February of this year contracts had been placed with component manufacturers for preliminary studies on reliability of electronic components and for antijamming problems associated with the system. A system specification had been completed, and system parameters fixed. Preliminary development system specifications were prepared, as were contracts for the high-powered electronic components and ground electronics.

This program also includes new research effort and design work on high reliability long-life satellite components, solid state devices for use at microwave frequencies and applications of molecular electronics techniques. Research studies included optimum band utilization, anti-jamming and long-life kilomegacycle tubes. Frequencies as high as 8,000 megacycles are contemplated.

Advent Program calls for several series of launches of intermediate orbit tests before the 19,000 mile system will be attempted. Atlas boosters with Agena and Centaur second stages will be used.

* Precision Navigation Satellites: 1960, $19 million; 1961, $7 million.

This is the Navy's Transit program designed to provide position accuracy within a fraction of a mile for ship, submarines or aircraft. In addition to the successful launching of a satellite this month two additional attempts are now scheduled from the Atlantic Missile Range.

* Project Sheperd: 1960, $17,570,000; 1961, $18 million.

This is the national satellite tracking and data acquisition program. It includes development of a satellite detection fence to detect, identify and track "silent" satellites and is based on a series of modified active minitrack stations across the southern U.S., a system known as Spasur. A second project is Spacetrack, which has the objectives of receiving and analyzing orbital data from various sources. A third major project is for installation of tracking and data collecting devices overseas. ARPA is also studying future possible approaches to detection, tracking and data collection.